Seasonal Studies at High Altitudes*

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AT the suggestion of Professor A. H. Compton a series of flights with unmanned balloons carrying cosmic-ray apparatus has been carried out covering the period from October, 1938, to the present. The purpose of these flights was to determine whether the seasonal effect observed on the ground persists up to very high altitudes. The apparatus is of the recording type and has a mass of 3000 to 3500 grams. The ionization chamber method is used, the chamber being a sphere 15 cm in diameter with 0.05 cm steel walls and filled to 10 atmosphere of argon. The most important part of the apparatus is an electrometer designed by Dr. Dershem of this laboratory, which is fitted with an especially rugged suspension and meticulously balanced to give the same deflection with the electrometer oriented in any position. A beam of light is reflected from the mirror on this instrument and the image of the light source traverses the length of a slit behind which moves a drum carrying bromide paper. The insulated system is grounded every $3\frac{1}{2}$ minutes and the electrometer voltage sensitivity is recorded on every fifth grounding. The pressure device is of the metal bellows type, the bellows being very flexible and the spring very stiff. Hysteresis effects are thus eliminated. Eight flights have been made since October, seven of these with the same apparatus. In each flight the apparatus attained an altitude sufficient to define clearly the maximum of cosmic-ray intensity. The minimum pressure recorded was 1.6 cm. Before each flight the set was calibrated in terms of a radium standard at a standard distance and with a standard geometrical arrangement. All cosmic-ray values were reckoned relative to this standard calibration. For purely relative cosmic-ray measurements there was thus avoided the necessity of knowing with any accuracy the absolute values of the capacity, the timing interval, or the density of the gas in the ionization chamber.

From November 1 to April 1 but little change was observed in the maximum intensity of cosmic rays. A flight on April 18 showed a very small diminution of the peak value. Flights on May 30 and June 10, the former with a new apparatus and the latter with the apparatus used during the winter, showed a peak value about 10 percent lower than the highest value attained during the winter in February or March. This change is about ten times the estimated error of experiment. With increasing barometric pressures this change can be traced at least up to 8 cm pressure and possibly beyond. To call this a seasonal change in cosmic rays at high altitudes would be premature until experiments have covered the full cycle of a year. It agrees, however, with the recently reported results of Millikan and Neher who found a diminution of cosmic-ray intensity at Omaha in summer flights as compared with that in winter flights.

From some of the winter flights it appeared that the pressure at which the maximum value of cosmic-ray intensity occurred shifted slightly in the direction of higher pressures as compared with the spring and autumn flights. One cannot be sure, however, that this effect is greater than the experimental error in the determination of pressure.

* For complete paper see an early issue of *The Physical Review*.